



January 2023

# DRONES

## FAA Should Improve Its Approach to Integrating Drones into the National Airspace System

Accessible Version

# GAO Highlights

Highlights of [GAO-23-105189](#), a report to congressional requesters

## Why GAO Did This Study

Drones can provide significant social and economic benefits. For example, drones can be used to inspect infrastructure, aid in disaster and wildfire response, and deliver medical supplies.

GAO was asked to review FAA's efforts to integrate drones into the national airspace system. This report examines, among other issues, the extent to which: (1) FAA's approach to managing its drone integration efforts is consistent with key elements for a comprehensive strategy and (2) FAA has clearly communicated its requirements and process for reviewing and approving operational requests.

GAO analyzed FAA's planning documents and reports. GAO interviewed FAA officials, eight participants in one of FAA's pilot programs, and 15 industry groups, representing manufacturers, operators, and others. GAO selected industry stakeholders due to their participation in FAA pilot programs and rulemaking advisory committees, among other factors.

## What GAO Recommends

GAO is making four recommendations, including that FAA: (1) develop a drone integration strategy that includes all elements of a comprehensive strategy and (2) evaluate its current documentation to identify options to more clearly communicate how applicants can satisfy drone operational request requirements and FAA's process for reviewing and approving operational requests. FAA concurred with GAO's recommendations.

View [GAO-23-105189](#). For more information, contact Heather Krause at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov).

January 2023

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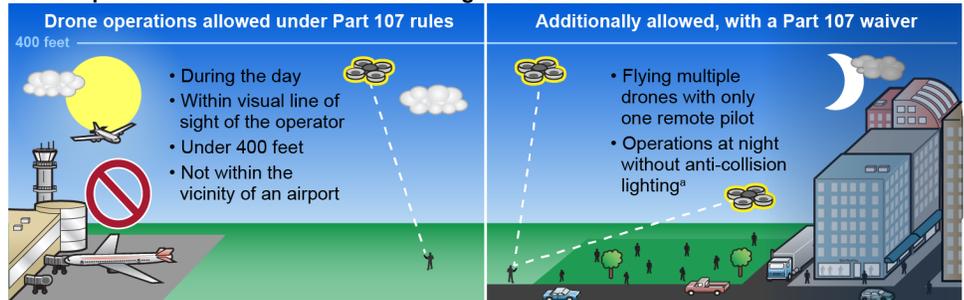
## FAA Should Improve Its Approach to Integrating Drones into the National Airspace System

### What GAO Found

The Federal Aviation Administration (FAA) is responsible for safely integrating drones into the national airspace system—a complex network that includes airports, aircraft, and air traffic control facilities. FAA has developed various planning documents to manage its drone integration efforts but has not developed a comprehensive strategy. GAO found that FAA's documents partially include four of the seven elements of a comprehensive strategy but do not include the remaining three elements. For example, FAA's documents describe activities that are completed, under way, and planned. However, the documents do not identify drone integration goals and objectives and partially include milestones and performance measures for all activities. FAA officials stated they are developing a drone integration strategy. However, the strategy's release has been delayed multiple times, and whether the strategy will provide a comprehensive approach is unclear. Establishing a strategy with all key elements is critical to FAA's ability to effectively manage its drone integration efforts.

FAA has not clearly communicated: how drone operators' requests to conduct advanced operations can meet specific requirements or what is FAA's process for reviewing and approving those requests. Currently, drone operators seeking to conduct advanced operations not allowed under existing rules must submit operational requests by applying for waivers or exemptions to conduct these operations (see example in fig.). However, more than half of 15 industry stakeholders told GAO that FAA has not clearly communicated the requirements it looks for when reviewing and approving advanced operations. As a result, they faced challenges working with multiple FAA offices on these requests. For example, stakeholders said they experienced lengthy reviews of their requests, and at times received conflicting information from different FAA offices. FAA officials said that they recognize that their process for reviewing operational requests is complex and that they plan to take steps to improve FAA's guidance. By more clearly communicating how to satisfy FAA's requirements and FAA's process for reviewing operational requests, applicants could be better positioned to provide FAA with the quality information needed to assess these requests.

Drone Operations Allowed under Part 107 Regulations and with a Waiver



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105189

<sup>a</sup>Pilots may fly at night if they have completed an initial knowledge test or training under 14 C.F.R. § 107.65 after April 6, 2021. In addition, the drone must have lighted anti-collision lighting visible for at least 3 statute miles that has a flash rate sufficient to avoid a collision. 14 C.F.R. § 107.29.

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### Abbreviations

ASSURE	Alliance for System Safety of UAS through Research Excellence
C2	command and control
DAA	detect and avoid
DOD	Department of Defense
DOT	Department of Transportation
DOT OIG	DOT Office of Inspector General
Drone	Small Uncrewed Aircraft System
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
IPP	Integration Pilot Program
NAS	national airspace system
NDDOT	North Dakota Department of Transportation
Remote ID	Remote identification of drones
RPAS	Remotely Piloted Aircraft Systems
SRM	safety risk management
UAS	uncrewed aircraft system
UPP	UTM Pilot Program
UTM	UAS Traffic Management
VT-MAAP	Virginia Tech Mid-Atlantic Aviation Partnership

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January 26, 2023

The Honorable Sam Graves  
Chair  
The Honorable Rick Larsen  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

The Honorable Garret Graves  
House of Representatives

Small drones (uncrewed aircraft systems or unmanned aircraft systems) have the potential to provide significant social and economic benefits in the United States.<sup>1</sup> Specifically, drone operations offer a wide range of potential applications in areas such as inspecting infrastructure, aiding in disaster and wildfire response, and delivering medical supplies. For example, during the COVID-19 pandemic, drones were utilized for a broad range of tasks where social-distancing measures were needed, including contactless distribution of personal protective equipment and delivery of testing and medical supplies to hospitals.

Drone use is expected to continue to increase. The Federal Aviation Administration (FAA) forecasted that between 2021 and 2026, the recreational drone fleet (those operated for personal interest and enjoyment)<sup>2</sup> will increase from about 1.58 million to 1.81 million and that the commercial drone fleet (those operated in connection with a business)

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<sup>1</sup>An uncrewed (unmanned) aircraft system consists of an uncrewed aircraft and its associated elements—including the components that control the aircraft and the associated communication links—that are required for safe and efficient operation in the national airspace system (NAS) 14 C.F.R. §§ 1.1, 107.3. For the purposes of this report, we use the term “drone” to refer to small uncrewed aircraft which are defined as uncrewed aircraft weighing less than 55 pounds. 14 C.F.R. § 107.3.

<sup>2</sup>A pilot may fly a drone recreationally and thus without specific certification or operating authority from the FAA, if the pilot complies with the statutory exception for limited recreational operations. 49 U.S.C. § 44809. Those requirements include, for example, that the aircraft is flown: strictly for recreational purposes, in accordance with or within the programming of a community-based organization, within the visual line of sight of the person operating the aircraft, and in a manner that does not interfere with and gives way to any crewed aircraft, among other requirements. 49 U.S.C. § 44809(a)(1)-(4).

will grow from 622,000 to 858,000.<sup>3</sup> According to FAA, the commercial drone industry in particular is expected to expand rapidly as commercial drones become operationally more efficient and safe, battery life expands, and drone regulations evolve to support more complex drone operations. FAA is responsible for ensuring that drones are integrated safely into the national airspace system (NAS)—a complex network that includes airports, aircraft, and air traffic control facilities. FAA defines a fully integrated NAS as one where drones of all sizes operate seamlessly with crewed aircraft in the same airspace. According to FAA, full integration of drones will require, among other things, the development of new regulations, industry standards, aircraft certification requirements, and infrastructure, such as an uncrewed aircraft system (UAS) traffic management system (referred to as UTM) intended to provide drone air navigation services in low-altitude airspace, which is below 400 feet.<sup>4</sup>

Since 2015, FAA has taken several steps to integrate routine and low-risk drone operations into the NAS. For example, in June 2016 FAA issued the Part 107 rule, which established requirements for routine operations of drones weighing less than 55 pounds, including that the drones remain within the operator’s or designated visual observer’s visual line of sight.<sup>5</sup> However, our prior work has shown that FAA could do more to improve its efforts to integrate complex drone operations into the NAS. For example, in 2020, we recommended that FAA take steps to more effectively leverage data and information it collected from drone operations conducted at test sites to inform integration efforts.<sup>6</sup> We recommended that FAA: (1) develop a plan for analyzing currently collected UAS test site data to determine how they could be used to advance drone

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<sup>3</sup>Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2022-2042* (Washington D.C.: March 2022).

<sup>4</sup>UTM is a traffic management ecosystem for uncontrolled drone operations consisting of various interconnected systems for managing multiple UAS operations. The FAA envisions that UTM will be a separate but complementary system to the FAA’s air-traffic management system.

<sup>5</sup>Part 107 allows for the operation of small UAS in the NAS. Part 107 is the default rule for all small UAS operations in the NAS. Public safety operators may operate under Part 107 or Part 91. Recreational users may fly under the exception for limited recreational operations under 49 U.S.C. § 44809 if the users meet all of the requirements listed in the statute. If they fail to meet any of the statutory requirements, they must operate under Part 107.

<sup>6</sup>GAO, *Unmanned Aircraft Systems: FAA Could Better Leverage Test Site Program to Advance Drone Integration*, [GAO-20-97](#) (Washington D.C.: Jan. 9, 2020).

integration and (2) publicly share more information on how the test site program informs integration while continuing to protect information deemed proprietary. FAA subsequently took steps to implement these recommendations. In 2021, we found that FAA had yet to provide industry and public stakeholders with information about its plans for developing a UTM system needed to support more complex operations involving multiple and highly automated drones.<sup>7</sup> We recommended that FAA provide stakeholders with additional information on the timing and substance of future UTM-testing and implementation efforts and that FAA develop performance goals and measures for its UTM implementation plan.<sup>8</sup>

You asked us to review FAA's efforts to integrate drones into the NAS. We examined four objectives:

1. the extent to which FAA's approach to managing its drone integration efforts is consistent with key elements of a comprehensive strategy;
2. the extent to which FAA has clearly communicated its requirements and process for reviewing and approving requests to conduct drone operations;
3. the extent to which FAA has a formal lessons-learned process for key drone integration activities; and
4. challenges to integrating drones and FAA's actions to address these challenges.

To address all objectives, we reviewed relevant statutes, regulations, and FAA documents describing FAA's approach to managing drone integration, as well as our previously issued reports on FAA drone integration efforts. FAA documents we reviewed included FAA's *Implementation Plan for Integration of UAS into the National Airspace System (NAS) (UAS Implementation Plan)*;<sup>9</sup> *Integration of Civil UAS in the National Airspace System (NAS) Roadmap, Third Edition (UAS*

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<sup>7</sup>GAO, *Unmanned Aircraft Systems: FAA Could Strengthen Its Implementation of a Drone Traffic Management System by Improving Communication and Measuring Performance*, [GAO-21-165](#), (Washington D.C: Jan. 28, 2021).

<sup>8</sup>As of December 2022, FAA has not implemented our recommendations.

<sup>9</sup>FAA, *Implementation Plan for Integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS), FY 2020 UAS Implementation Plan* (Washington, D.C.: Feb.18, 2020).

*Roadmap*);<sup>10</sup> *UAS Integration Research Plan 2020–2025* (UAS Research Plan);<sup>11</sup> and FAA office business plans. We also interviewed officials from offices within Aviation Safety, including the UAS Integration office and the Flight Standards Service, Office of Environment and Energy, and Air Traffic Organization about their roles and responsibilities, progress with integrating drones, challenges to drone integration, and actions FAA is taking to address challenges. We selected these four FAA offices because they are the offices that are primarily involved in the selected integration activities that were the focus of our review.

Further, we conducted semi-structured interviews with 15 selected drone industry representatives and with all eight lead participants of FAA’s current drone integration pilot program called the BEYOND program. We also interviewed representatives from the Department of Defense, to learn more about how they coordinate with FAA on drone integration efforts and to obtain their views on FAA’s integration efforts.<sup>12</sup> We selected industry stakeholders that participated in FAA pilot programs and rulemaking advisory committees, and considered in our selection recommendations from FAA. In addition, we included in our selection a mix of technology and network infrastructure companies, manufacturers, and operators, to ensure we had a range of perspectives. See appendix I for a full list of entities we interviewed.

To assess the extent to which FAA’s approach to managing its drone integration is consistent with key elements for a comprehensive strategy, we reviewed FAA’s planning documents describing FAA’s ongoing and planned drone integration activities. We assessed the extent to which these documents contain the key elements of a comprehensive strategy that we have identified in prior work. Specifically, in our prior work, we identified seven elements that are necessary for a strategy to be

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<sup>10</sup>FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap, Third Edition* (2020).

<sup>11</sup>FAA, *UAS Integration Research Plan 2020-2025, Edition Four* (Feb. 26, 2021).

<sup>12</sup>We selected the Department of Defense (DOD) because it is a major user of the NAS and because it was an early and frequent operator of drones. FAA also coordinates with other federal agencies, such as the National Aeronautics and Space Administration (NASA), on the development of a UTM.

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comprehensive.<sup>13</sup> We determined that these elements were all applicable to FAA's efforts.

To assess the extent to which FAA has clearly communicated its requirements and process for reviewing and approving requests to conduct drone operations, we reviewed FAA documents describing its policies and process for reviewing applications for these operations. This review included documents describing its process for reviewing drone operation requests requiring a Part 107 waiver application, exemptions requests to existing rules, and Part 135 certification. We also reviewed guidance that FAA has shared with applicants seeking to conduct these operations. We assessed FAA's documentation against *Standards for Internal Control in the Federal Government* that call for documentation to help management oversee execution of procedures. These standards also call for federal agencies to communicate with external entities to enable those entities to provide quality information that will help the agency achieve its objectives.<sup>14</sup>

To assess the extent to which FAA has a formal lessons learned process for its key drone integration activities, we selected four activities for our review: FAA's UTM Pilot Program (UPP); UAS Integration Pilot Program (IPP); BEYOND program; and FAA's review of Part 107 waiver applications.<sup>15</sup> We selected these activities because:

- FAA officials identified them as key integration activities;
- they are the primary activities through which FAA gains experience with complex drone operations;
- they represented a mixture of different types of integration activities—operational pilot programs, infrastructure pilot programs, and operational processes; and

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<sup>13</sup>The seven "key elements" of a comprehensive strategy include elements we identified in GAO, *Managing for Results: Critical Issues for Improving Federal Agencies' Strategic Plans*, [GAO/GGD-97-180](#) (Washington, D.C.: Sept. 16, 1997); and GAO, *Defense Logistics: A Completed Comprehensive Strategy is Needed to Guide DOD's In-Transit Visibility Efforts*, [GAO-13-201](#) (Washington, D.C.: Feb. 28, 2013).

<sup>14</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington D.C., September 2014).

<sup>15</sup>These requirements are contained in FAA's Part 107 rule, issued in 2016. 14 C.F.R. pt. 107.

- they represented a combination of completed and ongoing integration activities.

For each activity, we reviewed FAA documents, such as final reports from the completed pilot programs; interim reports and planning documents from the ongoing BEYOND program; and database documentation and copies of completed applications from the Part 107 waiver process, among others. We compared FAA's lessons-learned efforts for each activity to the six key practices of a lessons-learned process that we have identified in prior work, and determined the extent to which FAA's approach aligned with each practice.<sup>16</sup>

To identify challenges to integrating drones and examine FAA's actions to address these challenges, we reviewed documents from and interviewed officials with FAA about FAA's drone integration efforts. In addition, we performed a literature search to identify articles and reports discussing challenges to drone integration.<sup>17</sup> We did not evaluate the extent to which FAA actions are adequately addressing the technical and community challenges. In addition, we interviewed representatives from the National League of Cities and conducted semi-structured interviews with officials from the Choctaw Nation of Oklahoma<sup>18</sup> and representatives from eight selected cities and communities about their views on challenges to drone integration and concerns they have about drone integration. Collectively, we refer to these entities as community representatives in our report. We selected the cities and communities to obtain a variety of sizes and geographic locations and based on our review of news articles and literature, and recommendations from entities we interviewed.

Finally, we reviewed documents from FAA, Transport Canada, and the European Aviation Safety Agency (EASA), as well as other publicly available information about drone regulations in Canada and the European Union. We also performed a literature search to identify articles and reports discussing drone regulations in these locations. Information

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<sup>16</sup>GAO identified these key practices, among others, in GAO, *Federal Real Property Security: Interagency Security Committee Should Implement a Lessons-Learned Process*, [GAO-12-901](#) (Washington, D.C.: Sept. 10, 2012).

<sup>17</sup>The literature search was performed in September 2021, using keyword searches in bibliographic databases including ProQuest, EBSCO, Scopus, and Dialog. The literature search generated 113 initial results. We vetted this initial list by examining the abstracts for those that addressed our objectives and limiting our search to reports and articles published from 2016–2021. We identified 23 sources relevant to our review.

<sup>18</sup>The Choctaw Nation of Oklahoma is also a lead participant of FAA's BEYOND program, and as a result, we also interviewed them about their experiences with that program.

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about regulations in the United States, Canada, and the European Union is presented in appendix II. The information about foreign law in this report is not the product of our analysis but is derived from interviews and secondary sources.

We conducted this performance audit from April 2021 to January 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

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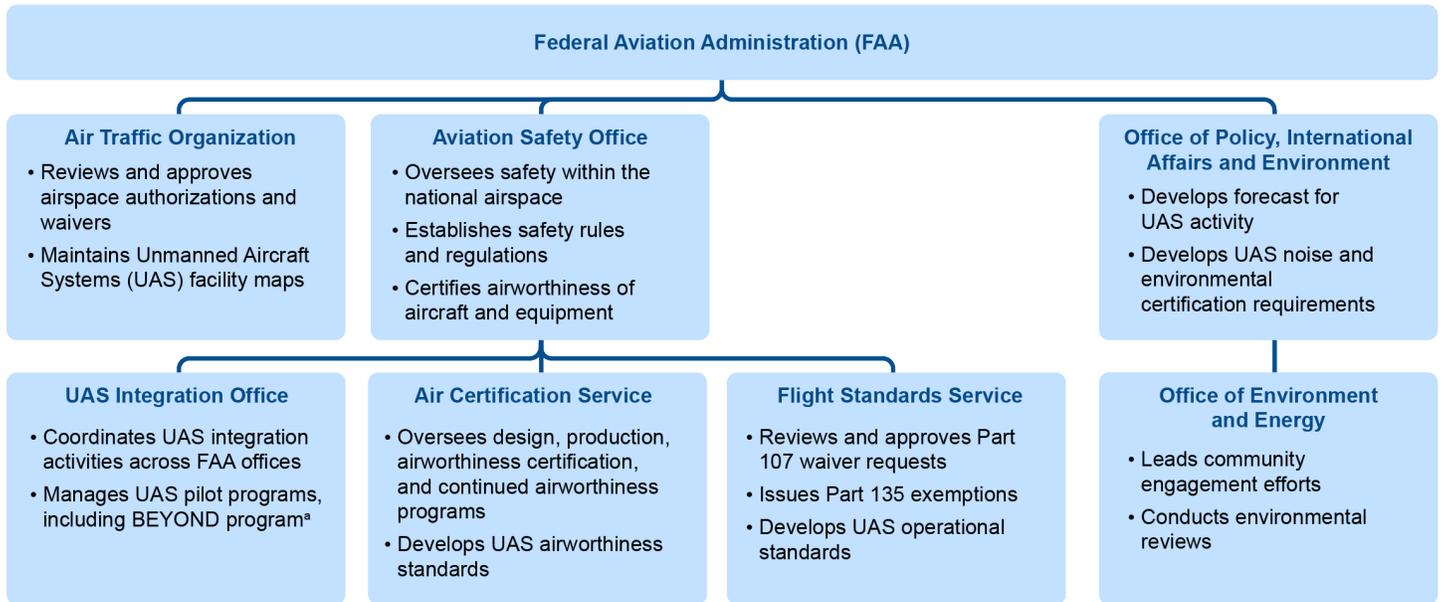
### FAA Offices Involved in Drone Integration Efforts

Several FAA offices are involved in efforts to integrate drones into the NAS (see fig.1). Within FAA's Office of Aviation Safety, the UAS Integration Office, Flight Standards Services, and Aircraft Certification Service have key responsibilities related to drone safety and integration. For example, the UAS Integration Office is responsible for coordinating drone integration activities across the agency. In addition, the Flight Standards Services is responsible for developing drone policy and regulations, developing operational requirements for drones, and reviewing and approving requests to operate drones, among other things.<sup>19</sup>

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<sup>19</sup>Security and Hazardous Materials Safety is responsible for hazardous materials issues and unique security risks posed by UAS, a subject that is outside the scope of this engagement.

**Figure 1: Federal Aviation Administration’s (FAA) Offices Involved in Key Drone Integration Efforts**



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105189

<sup>a</sup>The BEYOND program is FAA's ongoing drone integration program. According to FAA, the objectives of the BEYOND program are to, among other things, (1) advance beyond visual line-of-sight operations; (2) collect data and information to analyze and quantify the societal and economic benefits of drone operations; and (3) collect, analyze, and address community concerns related to drone operations.

## FAA Drone Integration Efforts

FAA has undertaken a range of activities to integrate drones into the NAS.<sup>20</sup> These activities are contained in various FAA plans and include developing rules (regulatory efforts); approving drone operations by granting waivers or exemptions to existing rules; and collecting data and information about drone operations through FAA's industry-partnership and pilot programs.

<sup>20</sup>The FAA Modernization and Reform Act of 2012 directed the FAA to develop a plan by September 2015 to safely accelerate the integration of drones into the NAS. Pub. L. No. 112-95, § 332, 126 Stat. 11, 73.

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## FAA Regulatory Efforts

As we have previously reported, FAA has taken an incremental approach to integrating drones by developing rules, policies, and procedures that allow for drone operations of gradually increasing risk and complexity.<sup>21</sup> As previously mentioned, in June 2016 FAA issued the Part 107 rule. Subsequently, in January 2021, FAA issued the following two final rules to enable more complex drone operations.

- **Remote identification of drones (Remote ID).** This rule requires drones in flight to provide identification information—such as the identity, location, and altitude of the drone and its control station or takeoff location—via radio frequency broadcast. The rule outlines multiple options to comply with the final rule and establishes design and production requirements that drone manufacturers are required to comply with, beginning September 16, 2022. Pursuant to the rule, drone operators must operate a Remote ID compliant drone beginning on September 16, 2023.<sup>22</sup>
- **Operations over people rule.** This rule allows drone operations over people, over moving vehicles, and at night, without a waiver or exemption, under certain conditions.<sup>23</sup> The final rule establishes four new categories of drones for routine operations over people and also permits operations at night and over a moving vehicle so long as the

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<sup>21</sup>GAO, *Small Unmanned Aircraft Systems: FAA Should Improve Its Management of Safety Risks*, GAO-18-110, (Washington, D.C.: May 24, 2018).

<sup>22</sup>In September 2022, FAA acknowledged that some manufacturers may not have sufficient time to adequately design, develop, and test their drones and file a declaration of compliance with the FAA. Accordingly, FAA stated it will exercise its discretion in determining how to handle any apparent noncompliance, including exercising discretion to not take enforcement action, if appropriate, for any noncompliance that occurs on or before December 16, 2022. Enforcement Policy Regarding Production Requirements for Standard Remote Identification Unmanned Aircraft, 87 Fed. Reg. 55685 (Sept. 12, 2022).

<sup>23</sup>See Operation of Small Unmanned Aircraft Systems Over People, 86 Fed. Reg. 4314 (Jan. 15, 2021).

operation meets specific requirements. The rule also made changes to the remote-pilot knowledge test requirement.<sup>24</sup>

FAA has other efforts under way to develop rules and policies to expand drone operations. For example, in 2021, FAA established a beyond visual line-of-sight aviation-rulemaking committee to develop recommendations for a rule that would enable operations beyond visual line-of-sight of a drone operator. The final report, issued in March 2022, included several recommendations to FAA for developing a final rule. These recommendations included that FAA establish acceptable levels of risks for drones that are consistent across all types of operations, develop noise certification requirements, and develop pilot trainings to increase drone awareness.<sup>25</sup> According to FAA officials, the FAA is planning a series of rulemaking efforts that will address the topics raised by the beyond visual line-of-sight aviation-rulemaking committee. FAA officials stated that they have started developing a Notice of Proposed Rulemaking which is anticipated to be published in early 2024.

In addition, in September 2020, FAA published a policy stating that it would begin accepting applications for type certification of some drones.<sup>26</sup> As part of the type certification process, FAA evaluates the design of the aircraft and all component parts, reviews the associated documentation, and evaluates how the aircraft performs across a wide range of conditions and flights. In September 2022, FAA awarded the first type certification to the Matternet M2 drone to be used for commercial delivery operations in the U.S.

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<sup>24</sup>Specifically, Part 107 previously required an initial aeronautical knowledge test or a recurrent aeronautical knowledge test within the previous 24 calendar months prior to operate a drone. The final rule revised these regulations to allow recurrent training instead of a recurrent aeronautical knowledge test. The final rule also required changes to the initial remote pilot knowledge test and the online recurrent training to include an operation at night knowledge section.

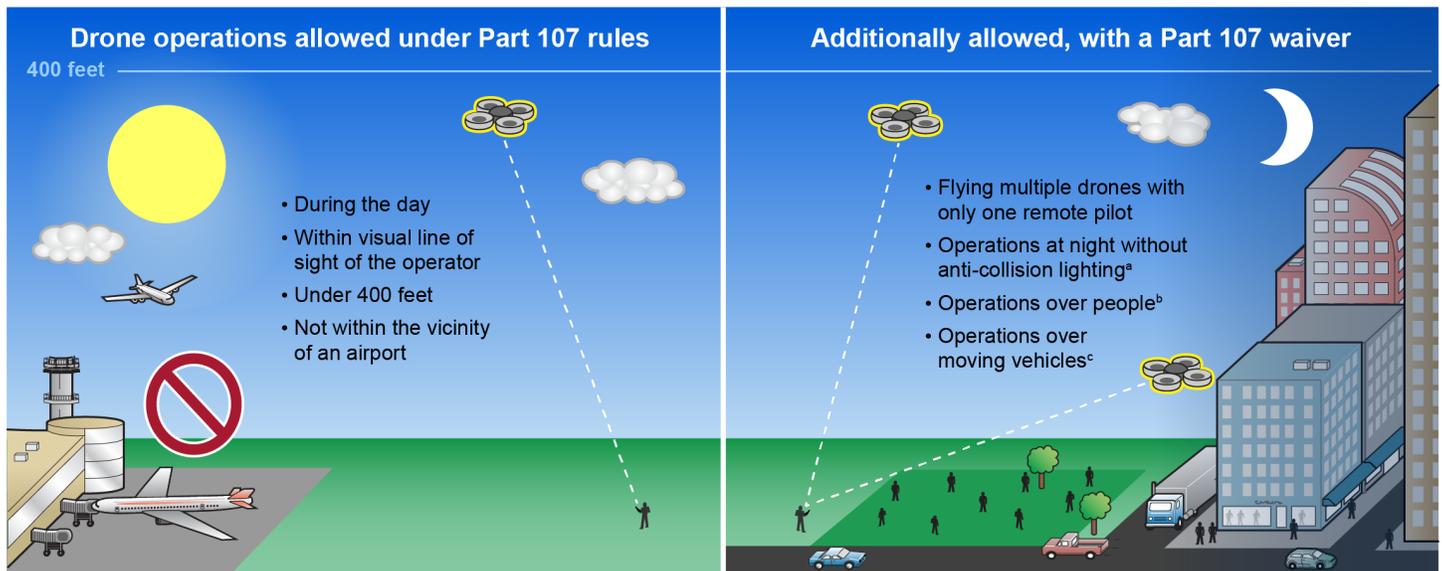
<sup>25</sup>UAS Beyond Visual Line of Sight Aviation Rulemaking Committee, *Unmanned Aircraft Systems Beyond Visual Line of Sight Final Report*, (Mar. 10, 2022).

<sup>26</sup>See Type Certification of Certain Unmanned Aircraft Systems, 85 Fed. Reg. 58251 (Sept. 18, 2020); see also 14 C.F.R. § 21.17(b). A type certificate allows manufacturers to demonstrate compliance with regulatory requirements and obtain approval of the aircraft's design.

## Operational Waivers and Other Operation Requests

Drone operators seeking to conduct operations outside the limitations under Part 107 rules or other rules must request waivers<sup>27</sup> or exemptions<sup>28</sup> to existing rules which we refer to as operational requests in this report.<sup>29</sup> For example, drone operators can apply for a Part 107 waiver to request permission to fly multiple drones with a single remote pilot (see fig. 2). FAA grants waivers on a case-by-case basis. To receive a Part 107 waiver or other exemption, an applicant must provide a complete description of the proposed operation and justification that establishes the operation can be conducted safely.

**Figure 2: Flight Operations Allowed for Small Uncrewed Aircraft Systems (Drones) Operating under Part 107 of the Federal Aviation Administration’s (FAA) Regulations**



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105189

<sup>27</sup>A waiver is an official document issued by the FAA that approves certain operations of aircraft outside the limitations of a regulation. For example, drone operators may request to fly specific drone operations not allowed under Part 107 by requesting an operational waiver.

<sup>28</sup>FAA may also approve drone operations by granting exemptions to applicable operating rules, aircraft requirements, and pilot requirements for a specific operation on a case-by-case basis.

<sup>29</sup>FAA also issues authorizations or approvals for operators to fly in controlled airspace, such as near airports, while still following existing regulations, and airworthiness certifications. 85 Fed. Reg. 58251, 58251.

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<sup>a</sup>Pilots may fly at night if they have completed an initial knowledge test or training under 14 C.F.R. §107.65 after April 6, 2021. In addition, the drone must have lighted anti-collision lighting visible for at least 3 statute miles that has a flash rate sufficient to avoid a collision. 14 C.F.R. § 107.29.

<sup>b</sup>A Part 107 waiver for operations over people is needed if the operation does not meet operational Categories 1, 2, 3 or 4. 14 C.F.R. Pt. 107, Subpart D.

<sup>c</sup>A Part 107 waiver for operations over moving vehicles is needed if the operation does not meet operational Categories 1, 2, 3, or 4 or other conditions. 14. C.F.R. § 107.145.

In addition, FAA has approved air carrier certificates for drone cargo delivery under Part 135 regulations. Specifically, operators that want to conduct commercial package delivery operations beyond visual line-of-sight must apply to obtain a Part 119 air carrier certificate for operations under Part 135.<sup>30</sup> Because the Part 135 regulations contain requirements relevant to crewed aircraft, drone-related applicants apply for exemptions for rules under Part 135 that do not apply to drones. These exemptions include, for example, the requirement to carry the flight manuals on board the aircraft. U.S. drone operators must go through FAA's existing five-phase air carrier certification process to receive an air carrier certificate for Part 135 operations. FAA issues air carrier certificates based on the type of services the drone operator plans to provide and where it wants to conduct the operations. According to FAA officials, the operators receive exemptions, then complete Part 135 certification activities. The exemptions are publicly available.

As of September 2022, FAA had received 48 requests for a Part 135 air carrier certificate for drones and had issued four Part 135 certifications to the following companies: Wing Aviation, LLC, in April and October 2019;<sup>31</sup> United Parcel Service Flight Forward in September 2019; Amazon in August 2020; and most recently to Zipline in June 2022. Until FAA takes additional regulatory actions, drone operators will continue to need to apply for waivers and other operational requests to allow them to conduct more complex operations.

### FAA Pilot Programs and Partnership Arrangements

FAA has also initiated several pilot programs and partnership arrangements to develop and test advanced drone concepts, capabilities, and operations. For these efforts, FAA has partnered with drone

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<sup>30</sup>FAA officials confirmed that under their regulations, Part 135 certification is currently the only path for small drones to carry the property of another for compensation beyond visual line-of-sight.

<sup>31</sup>Wing was issued one certificate. It was initially certificated as a Part 135 Single Pilot in Command operator. Subsequently it applied for and had its certificate modified to increase its scope of operations as a Standard Part 135 operator.

operators and manufacturers, universities, and tribal, state, and local governments. According to FAA, information and data collected from these programs are helping inform the agency's efforts to develop drone rules and facilitate integration. These programs include the UTM Pilot Program (UPP), UAS Integration Pilot Program (IPP), and BEYOND program.

- **UTM Pilot Program (UPP).** UTM is intended to provide drone air navigation services in low-altitude airspace, which is below 400 feet.<sup>32</sup> In 2015, as directed by the FAA Extension, Safety, and Security Act of 2016, FAA and the National Aeronautics and Space Administration (NASA) began collaborating on the development and implementation of UTM. The FAA Extension, Safety, and Security Act of 2016 directed FAA to establish the UPP to, according to FAA, ensure that NASA research was transferred to FAA to support UTM implementation. FAA initiated the UPP program in April 2017 to conduct demonstrations, identify initial capabilities needed to support operations using a UTM system, and to evaluate FAA and NASA's research of UTM capabilities. According to FAA, the results of this research will serve as the basis for initial deployment of UTM capabilities. The UPP program was completed in November 2020, and FAA issued the final report for UPP on August 10, 2021.
- **UAS Integration Pilot Program (IPP).** In response to an October 2017 Presidential memorandum, FAA launched the IPP to accelerate drone integration into the NAS.<sup>33</sup> The purpose of the IPP was to address technical, regulatory, and policy challenges and to advance complex drone operations. In May 2018, the Department of Transportation, through the FAA, established memorandums of agreements with 10 tribal, state, and local governments (lead participants) to conduct advanced drone operations as part of the

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<sup>32</sup>Air navigation services refers to air traffic services provided to monitor, direct, and guide aircraft or flows of aircraft safely in the NAS. These services include communications, navigation, and surveillance services.

<sup>33</sup>*Presidential Memorandum on Unmanned Aircraft Systems Integration Pilot Program*, 82 Fed. Reg. 50301 (Oct. 25, 2017).

program.<sup>34</sup> These lead participants partnered with private sector entities such as drone operators and manufacturers to accelerate the approval of operations that currently require waivers, exemptions, or authorizations on a case-by-case basis. During IPP, the FAA, nine lead participants, and their industry partners, conducted more than 21,000 flight operations. FAA ended the IPP in October 2020, as required by the FAA Reauthorization Act of 2018, and issued a final report on the results of the program on December 17, 2021.

- **BEYOND Program.** After ending the IPP, FAA launched a new program—BEYOND. The BEYOND program succeeded the IPP, and eight of the original nine lead participants are participating in this program.<sup>35</sup> The program began in October 2020 and is scheduled to end in October 2024. According to FAA, the objectives of the BEYOND program are to, among other things, (1) advance beyond visual line-of-sight operations; (2) collect data and information to analyze and quantify the societal and economic benefits of drone operations; and (3) collect, analyze, and address community concerns related to drone operations.

FAA has several other mechanisms to collaborate with different organizations on drone related research activities. For example, through the UAS Partnership for Safety Plan Program, FAA established memorandum-of-understanding agreements with industry partners to coordinate on safety cases necessary for conducting complex drone operations. In addition, the FAA has a Center of Excellence for UAS Research — also known as the Alliance for System Safety of UAS through Research Excellence (ASSURE) — that brings together 23 aviation universities, including two international universities, to conduct drone integration research. In addition, FAA has seven designated test sites to enable both private-sector firms and public entities to test

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<sup>34</sup>The lead participants included North Dakota Department of Transportation, City of Reno (Nevada), Kansas Department of Transportation, Memphis Shelby County Airport Authority (Tennessee), Innovation and Entrepreneurship Investment Authority (Virginia), North Carolina Department of Transportation, Choctaw Nation of Oklahoma, City of San Diego (California), and University of Alaska Fairbanks. Lee County Mosquito Control District (Florida) was originally selected to participate in the IPP, but later withdrew from the program due to funding constraints.

<sup>35</sup>The City of San Diego is not participating in the BEYOND program as a lead participant due in part to resource constraints.

complex drone operations and conduct research on drone technologies.<sup>36</sup> FAA has also established the Advanced Aviation Advisory Committee—made up of participants from various companies, tribal, state, and local governments, airports, and the aviation community—to provide FAA with advice on key drone and advanced air mobility integration issues.

## FAA Has Not Developed a Comprehensive Strategy to Integrate Drones

FAA has developed a number of documents and plans to manage its drone integration efforts but has not developed an agency-wide strategy that includes key elements of a comprehensive strategy. Specifically, FAA has developed a *UAS Roadmap*, *UAS Implementation plan*, and *UAS Research Plan*. In addition, individual FAA offices and staff offices develop annual fiscal year business plans that describe activities each FAA office will undertake in support of all FAA initiatives, including FAA drone integration efforts. Collectively, these documents describe the drone integration activities completed, under way, and planned across the agency, including activities related to FAA’s pilot programs, regulatory efforts, and efforts to approve drone operations. According to FAA officials, these documents are the principal documents that the agency uses to manage the agency’s integration efforts. (See table 1).

**Table 1: The Federal Aviation Administration’s (FAA) Current Planning Documents Identifying Drone Integration Efforts**

Document and dates	Description
Fiscal Year 2020 Implementation Plan for Integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS) ( <i>UAS Implementation Plan</i> )	FAA’s internal <i>UAS Implementation Plan</i> describes drone integration activities planned and under way across the agency. FAA uses this plan to track drone integration activities and to coordinate with FAA offices on these activities. This plan captures the activities identified in the individual FAA office business plans.
Fiscal Year 2020 Integration of Civil Unmanned Aircraft Systems in the NAS Roadmap, Third Edition ( <i>UAS Roadmap</i> )	FAA’s <i>UAS Roadmap</i> provides an update on FAA’s progress with integrating drones, describes FAA’s planned efforts for the next 5 years, and identifies challenges that the agency faces.

<sup>36</sup>Specifically, the seven test sites are: North Dakota Department of Commerce (which is managed and operated by the Northern Plains UAS Test Site), State of Nevada, New Mexico State University, University of Alaska Fairbanks, Texas A&M University at Corpus Christi, Virginia Polytechnic Institute & State University, and Griffiss International Airport (New York). Northern Plains UAS Test Site, University of Alaska Fairbanks, and Virginia Polytechnic Institute & State University, are also participating in FAA’s BEYOND program.

Document and dates	Description
Fiscal Year 2021, UAS Integration Research Plan 2020-2025, Edition 4 (UAS Research Plan)	FAA's UAS Research Plan outlines the agency's drone research needs, research projects under way, and planned research to achieve FAA drone integration milestones.
Fiscal Years 2020, 2021, and 2022 FAA Office Business Plans	FAA offices update and publish individual business plans on an annual basis. These plans include descriptions of activities that the individual offices are undertaking, including activities to integrate drones.

Source: GAO analysis of FAA documents. | GAO-23-105189

Note: FAA has issued prior versions of the *UAS Implementation plan*, *UAS Roadmap* and the *UAS Research Plan*.

Each of FAA's planning documents contains information about FAA's drone integration efforts, but we found that collectively these documents do not constitute a comprehensive strategy. In our prior work, we have identified seven key elements necessary for a comprehensive strategy.<sup>37</sup> We have previously found that developing a comprehensive strategy that includes these seven elements could help agencies further develop and implement their strategies, enhance their usefulness in resource and policy decisions, and better assure accountability. We found that FAA's planning documents partially includes four of the seven elements of a comprehensive strategy but do not include the remaining three elements. Table 2 describes the seven key elements of a comprehensive strategy, and shows the results of our assessment on the extent to which FAA's planning documents include these elements.

**Table 2: Extent to which the Federal Aviation Administration's (FAA) Planning Documents Include Key Elements of a Comprehensive Strategy**

Key element of a comprehensive strategy	Description of key element	Element included in FAA planning documents	GAO Assessment
<b>Mission statement</b>	A comprehensive statement that summarizes the main purpose of the strategy.	FAA's planning documents do not include a comprehensive mission statement articulating FAA's drone integration strategy.	Do not include
<b>Problem definition, scope, and methodology</b>	Presents the issues to be addressed by the strategy; the scope the strategy covers; and the process by which it was developed.	FAA's planning documents define the issues that FAA faces with integrating drones, but do not clearly document the methodology used to develop goals, objectives, and actions to address these issues.	Partially include
<b>Goals and objectives</b>	Description of the goals and objectives to be achieved by the strategy.	FAA's planning documents do not clearly articulate FAA's agency-wide goals and objectives for integrating drones.	Do not include

<sup>37</sup>GAO-13-201 and GAO/GGD-97-180.

Letter

Key element of a comprehensive strategy	Description of key element	Element included in FAA planning documents	GAO Assessment
<b>Activities, milestones, and performance measures</b>	Description of steps to achieve those results, as well as milestones and performance measures to gauge results.	FAA's planning documents describe drone integration activities that the agency has planned or under way. Milestones and performance measures are included for some, but not all activities.	Partially include
<b>Resources and investments</b>	Costs to execute the plan and the sources and types of resources and investments, including skills and technology and the human, capital, information, and other resources required to meet the goals/objectives.	FAA planning documents do not include any discussion of resources and investments needed.	Do not include
<b>Organizational roles, responsibilities, and coordination</b>	Description of roles and responsibilities for managing and overseeing the implementation of the strategy and the establishment of mechanisms for multiple stakeholders to coordinate their efforts throughout implementation and make necessary adjustments to the strategy based on performance.	FAA's planning documents describe activities that individual FAA offices are responsible for. However, these documents do not describe how FAA offices will coordinate to ensure activities are completed.	Partially include
<b>Key external factors that could affect goals</b>	Key factors external to the organization and beyond its control that could significantly affect the achievement of the long-term goals contained in the strategy.	FAA planning documents partially include a discussion of external factors that could pose a risk to FAA's ability to integrate drones	Partially include

Source: GAO analysis of FAA documents. | GAO-23-105189

Note: We determined that FAA's planning documents "fully include" an element if the documents described the entire element, and "partially include" an element if FAA's planning documents describe some, but not all, parts of that element. If FAA's planning documents did not explicitly cite any of the parts of an element, we determined that these documents "do not include" the element.

Based on our analysis of FAA's planning documents, we determined that FAA's documents partially include a description of the problems and issues that FAA faces with integrating drones; integration activities that FAA is undertaking or has planned; a description of FAA offices responsible for completing drone integration activities; and information about key external factors that could affect the agency's achievement of its drone integration goals. However, FAA's planning documents do not fully include all parts of these four elements. For example, while FAA's planning documents describe FAA's drone integration activities, we found that these documents were missing milestones and performance measures to gauge results. In addition, FAA's *UAS Roadmap* is intended to provide an update on the progress that FAA has made with integrating drones and provide a 5-year plan describing FAA's drone integration priorities going forward. However, we found that the *UAS Roadmap* does

not contain specific details about planned integration activities, including milestones and performance metrics associated with those activities.

Similarly, while FAA's *UAS Implementation Plan* and business plans describe the various activities that the agency is currently undertaking or has planned, we found that information across these documents was, in some cases, inconsistent or missing target milestones and performance measures. For example, some of the activities listed in the *UAS Implementation Plan* were not listed in the corresponding business plans or did not include an associated milestone date or performance measure. FAA officials acknowledged that they faced some challenges maintaining these documents with up-to-date information. According to FAA officials, these documents are updated at various points in time and, as a result, may not have consistent information. For example, FAA's *UAS Implementation Plan* was last updated for fiscal year 2020 and therefore may not reflect the most up to date information from the FAA offices' individual business plans.

In addition, FAA's planning documents do not include other elements of a comprehensive strategy. For example, they do not include a comprehensive mission statement; FAA's agency-wide drone integration goals and objectives; and information about the resources and investments that would be required to achieve the agency's goals. For example, FAA's *UAS Implementation Plan* and *UAS Roadmap* do not clearly articulate the agency's specific goals and objectives for integrating drones. Without clear goals and objectives for its drone integration efforts, FAA lacks a mechanism to assess the effectiveness of its drone integration efforts and to demonstrate its progress with integrating drones.

According to FAA officials, as of September 2022, FAA was in the process of developing a draft strategy intended to guide the direction and priorities of its drone integration efforts going forward. The officials also stated that once the new strategy is published, individual FAA offices plan to align their business plans and other planning documents to the new strategy. FAA officials said that they began developing a new strategy because they recognized that there was a need for a single comprehensive plan that reflected the agency's overall vision for drone integration. Further, FAA officials stated that they recognize aligning information from all of their individual documents into a single plan will reduce confusion and allow the agency to be more responsive to questions from Congress and external stakeholders.

FAA officials said that upon publication, the new strategy will replace the agency's *UAS Roadmap* and the *UAS Implementation Plan*, neither of which have been updated since 2020. However, the publication date of the drone integration strategy has been delayed multiple times. FAA officials told us that the initial publication date of the strategy was February 2022. That date was later revised to June 2022, and then to September 2022. As of October 2022, FAA officials said that the strategy has not been fully reviewed and was subject to change and that they expect the draft strategy to be published in the first quarter of calendar year 2023.

It is not clear the extent to which FAA's draft drone integration strategy will incorporate all seven key elements that we have previously identified are necessary for a comprehensive strategy. FAA officials told us that the strategy will be a high level document and will not include certain elements we have previously identified are needed in a comprehensive strategy, such as specific performance metrics, milestones, and information about resource needs. FAA officials said that these elements will instead be included in the individual FAA office business plans. While information about performance metrics, milestones, and resource needs can be documented in various FAA plans, incorporating this information in FAA's drone integration strategy would help ensure that the agency's various drone integration efforts are aligned.

In our prior work, we have found that incorporating all seven key elements of a comprehensive strategy is critical to ensuring the effectiveness of the strategy.<sup>38</sup> Specifically, developing a comprehensive strategy that includes all seven key elements could enhance its usefulness, better ensure accountability, and provide valuable direction to FAA's drone integration efforts. In particular, it will be critical that FAA's strategy clearly articulates the agency's vision, goals, and objectives for integrating drones—a key element that is missing from FAA's existing planning documents. Additionally, because multiple FAA offices are involved in FAA's integration efforts, establishing clear roles and responsibilities for carrying out FAA's drone integration activities and identifying specific milestones and performance measures for completing these activities will be integral to effectively implement the strategy and ensure accountability.

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<sup>38</sup>[GAO-13-201](#) and [GAO/GGD-97-180](#).

In addition, several industry stakeholders we spoke to stated that FAA had not made sufficient progress with various drone integration activities. Developing a comprehensive drone integration strategy that includes all seven key elements, may better position FAA to more effectively articulate to external stakeholders its progress and how various drone integration activities are helping the agency achieve its overall integration goals and objectives.

- Most industry stakeholders that we spoke to (11 out of 15) said FAA has not made sufficient progress with developing or implementing a type certification process for drones, which they said will be critical for enabling complex drone operations. Specifically, these stakeholders stated that FAA has not made progress with streamlining the type certification process for drones, developing a timeline for when the agency intends to make decisions on type certification requirements, nor developed clearer guidance for applicants seeking type certification. For example, one industry stakeholder stated that the type certification process is too lengthy and should not take 3-5 years to complete because equipment technology changes frequently and can be outdated in that amount of time. Another industry stakeholder we spoke to noted that now that FAA has done one drone type certification successfully, the stakeholder hopes that FAA can incorporate lessons learned from that review to streamline and improve the process moving forward for the broader industry. FAA officials stated that they have made significant progress with type certification. FAA awarded the first type certification to the Matternet M2 drone in September 2022, and FAA is continuing to review other type certification applications on a case-by-case basis. FAA officials said that they have to address several challenges and take a holistic approach to certify drones.
- Most industry stakeholders we interviewed (11 out of 15) said that FAA had not made sufficient progress with integrating drones. In addition, about half of the industry stakeholders we spoke to (nine out of 15) said that other countries were further along with developing a drone regulatory framework. Some of these stakeholders stated that it was critical that FAA set firm timeframes and clear processes for establishing a regulatory framework to enable advanced commercial drone operations and to ensure that the domestic drone industry remains competitive internationally. Similarly, at a recent hearing before the Senate's Subcommittee on Aviation Safety, Operations, and Innovation a representative from ASSURE stated that the FAA should develop a detailed regulatory plan that includes identification of specific regulations and standards, with associated milestones and

timeframes, to support industry and public safety.<sup>39</sup> FAA officials stated that developing performance-based regulations to support drone operations will take time. FAA officials noted that the agency is still in the data collection phase and will need to continue to collect more data and information to inform its decision-making and regulatory efforts. FAA officials also stated that in their view, the United States is further along than other countries in developing drone regulations. See appendix II for more information about drone regulations in the United States and in other countries.

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## FAA Has Not Clearly Communicated Its Process for Reviewing and Approving Operational Requests

Drone operators seeking to conduct more advanced operations not allowed under existing regulations can do so by requesting waivers—such as a waiver from Part 107 rules—or exemptions to other existing rules.<sup>40</sup> Until FAA has developed a regulatory framework to support advanced operations, such as beyond visual line-of-sight operations, operators will need to continue to request waivers or exemptions to existing rules to conduct these operations. These advanced operations include operations to conduct agriculture activities, monitor infrastructure and public safety, and deliver packages and medical supplies, and other uses.

FAA has developed several guidance, resources, and other documents for operators that are seeking approval to conduct advanced drone operations. However, we found that FAA's documents do not clearly communicate (1) how applicants can meet FAA's requirements for approving certain operational requests and (2) FAA's process for reviewing operational requests, including information about how different FAA offices are involved in these reviews.

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<sup>39</sup>Colonel (Ret.) Stephen P. Luxion, Executive Director of FAA's Alliance for System Safety of UAS through Research Excellence (ASSURE), testimony before the Senate Subcommittee on Aviation Safety, Operations, and Innovation, 117th Cong., 2nd sess., Sept. 28, 2022.

<sup>40</sup>In addition to applying for waivers and exemptions, some operators are also applying for air carrier and type certification to conduct more advanced operations.

In particular, FAA has developed Part 107 waiver application instructions and waiver safety explanation guidance, among other documents, that it posts on its website to communicate Part 107 waiver requirements to applicants. According to these documents, applicants are required to submit a concept of operation describing the proposed operation, location, limitations, and proposed procedures as well as an operational hazard and risk analysis document describing procedures in place to mitigate potential risks.

However, more than half of the industry stakeholders (nine out of the 15) we spoke to said FAA has not clearly communicated to applicants how they can satisfy requirements to obtain approval for requests to conduct advance operations. For example, one industry stakeholder we spoke to said that FAA could provide more clarity about what it is looking for with respect to approving waivers for advanced drone operations and the factors it currently considers when conducting its safety risk assessments. Another stakeholder stated that it had applied for a waiver to conduct a beyond visual line-of-sight operation and that FAA was unable to provide specific guidance and information about how to meet FAA's safety standards. In particular, this stakeholder said that FAA wants applicants to propose a mitigation approach, after which FAA will assess whether that approach is appropriate. According to this industry stakeholder, this trial and error approach makes it difficult for companies to justify continued funding of drone operations if there is no confidence that FAA will ultimately approve the request in a timely manner.

We reviewed FAA's Part 107 guidance and found that these documents do not provide detailed information about the risk mitigations that FAA would consider to be acceptable for a given operation. For example, FAA's guidance specifies that applications should include detailed descriptions and procedures for risk mitigations to avoid collisions with aircraft but does not provide examples of risk mitigations that FAA would approve. FAA officials stated that they are unable to provide detailed guidance on what types of operations will be approved because the agency is still in the process of working to define these requirements to assess the risk of new and complex operations. For example, industry standards for detect and avoid technologies have not yet been developed, and as a result, FAA is still determining how to assess this technology when it is to be used in a proposed operation. Additionally, FAA officials stated that there are legal constraints to the extent to which the FAA can create standardized waivers or exemptions, as the very nature of waivers and exemptions are exceptions to regulations. FAA officials said that while they strive to provide clear guidance on meeting

the safety requirements of their regulations, they believe that the responsibility for demonstrating the equivalent level of safety falls on the applicant.

However, industry stakeholders have stated that FAA could better communicate information about how applicants can meet applicable requirements in ways that the agency has already deemed acceptable, such as by developing standard scenarios or pre-defined risk assessments for certain drone operations. In its 2022 final report, FAA's beyond visual line-of-sight rulemaking committee emphasized the importance of FAA's improving its process for reviewing operational requests. Improvements the report recommended included communicating more information to industry, through standard scenarios, acceptable means of compliance, or pre-defined risk assessments.<sup>41</sup> According to the committee's report, these tools could be implemented in advance of a final beyond visual line-of-sight rule and would allow FAA to continue to review and approve operations while the agency is working on developing a final beyond visual line-of-sight rule. The committee also noted that FAA has already approved numerous operational requests conducted under Part 107 and Part 91 waivers and exemptions and that FAA could leverage information collected from these previously approved operations to develop these tools.

Similarly, at an October 2021 meeting of the Advanced Aviation Advisory Committee, the committee stated that pre-defined risk assessments and standard scenarios of common use cases could help FAA develop more precise guidance that clearly communicates FAA's requirements. According to the committee, these tools would enable operations in less risky environments using known effective mitigations and would allow the FAA to focus its efforts and oversight on higher risk operations. Further, two industry stakeholders we spoke to stated that FAA could provide more effective guidance by developing standard scenarios to streamline processes and define requirements for conducting lower risk, low-altitude beyond visual line-of-sight operations.

At a February 2021 meeting of the Advanced Aviation Advisory Committee meeting, FAA officials stated that the agency was open to working further with the Advanced Aviation Advisory Committee to

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<sup>41</sup>The beyond visual line-of-sight committee was comprised of representatives from academia and standards bodies; infrastructure security; privacy groups; tribal, state, and local interests; technology and network infrastructure interests; traditional aviation associations; and UAS associations, manufactures and operators.

develop sample standard scenarios. Further, FAA officials acknowledged that developing standard scenarios could help FAA streamline its evaluations of operational requests. However, FAA has not yet taken steps on this matter, nor has it outlined any plans to develop standard scenarios.

According to FAA's waiver data, between fiscal year 2019 and fiscal year 2021, FAA received a total of 17,098 Part 107 waiver requests. Of those requests, FAA approved 3,492 (about 20 percent) of Part 107 applications it received and denied 10,712 (about 63 percent) applications.<sup>42</sup> FAA officials told us that the majority of denials were because applicants did not provide complete information in their applications. *Standards for Internal Control in the Federal Government* state that federal agencies should communicate with external entities and enable those entities to provide quality information to the agency that will help it achieve its objectives.<sup>43</sup> Without clearer information describing how applicants can meet the requirements to obtain approval for operational requests, applicants may be unable to provide FAA with the quality information it needs to conduct its reviews.

In addition, FAA documents do not effectively communicate to applicants FAA's internal process for reviewing operational requests, including how FAA offices coordinate on these reviews. According to FAA documents and officials, several FAA offices are involved in reviewing operational requests. For example, the Flight Standards Service is involved in the review of multiple types of waivers and exemptions including Part 107 waivers and Part 135 and Part 137 exemptions. The Air Traffic Organization is also involved in the review of authorization requests and certain waiver requests. FAA officials said that Flight Standards Service officials may also coordinate with personnel in other offices to ensure they are obtaining input from staff with drone-related expertise.

While FAA's guidance and documents on its review processes note the offices involved, information regarding how FAA conducts its review of operational requests—and what each office might be reviewing—is not reflected in FAA documents. For example, FAA has developed a *UAS Safety Risk Management Policy* that describes FAA's process for

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<sup>42</sup>Of the total 17,098 Part 107 waiver requests received, 2,797 (about 16 percent) were withdrawn or canceled, and 97 (about 1 percent) were partially approved.

<sup>43</sup>[GAO-14-704G](#).

performing safety risk management assessments of operational requests that involve advanced operations.<sup>44</sup> This policy describes which FAA office is considered the office of primary responsibility for conducting the assessment, and lists the various FAA offices that may be involved in the safety assessments. However, this document does not specify at what point in the process certain offices are consulted and what level of input those FAA offices provide. *Standards for Internal Control in the Federal Government* calls for documentation to help management establish and communicate who, what, when, where, and why of procedures to personnel.<sup>45</sup>

In its 2022 review of FAA's IPP program, the DOT Office of Inspector General (OIG) found that IPP and BEYOND program participants reported facing a range of challenges working with FAA on operational requests due to internal coordination challenges within FAA.<sup>46</sup> Specifically, the DOT OIG reported that lead participants expressed frustration with communicating or coordinating, or both, with multiple FAA offices as part of the IPP. As a result, the DOT OIG recommended that FAA evaluate potential options to improve working across FAA offices for approving and integrating new UAS technologies.<sup>47</sup>

Industry stakeholders we spoke to also said they faced a variety of challenges navigating FAA's process for applying for operational requests and working with multiple FAA offices on these operational requests, due to a perceived lack of communication about how FAA offices coordinate on these reviews. For example, most industry stakeholders (10 out of 15) whom we spoke to stated that they have received conflicting information or differing opinions from FAA offices, an inconsistency that makes it challenging to work effectively with FAA. Specifically, one industry stakeholder said that it had received a waiver to operate a large drone

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<sup>44</sup>FAA applies this policy when reviewing requests for waivers, exemptions, or other requests.

<sup>45</sup>[GAO-14-704G](#).

<sup>46</sup>DOT Office of Inspector General, *FAA Made Progress Through Its UAS Integration Pilot Program, but FAA and Industry Challenges Remain To Achieve Full UAS Integration*, AV2022027 (Washington D.C: Apr. 27, 2022.)

<sup>47</sup>FAA concurred with the DOT IG's recommendation. According to FAA officials, they are taking several approaches to improve coordination across FAA offices. For example, FAA formed a team representing three lines of business to identify ways to improve the exemption process. FAA officials said they are also evaluating the recurring meetings related to drone integration to ensure that appropriate decision-makers are receiving the right information at the right time.

beyond visual line-of-sight. The stakeholder was later informed it could no longer use that drone for that specific operation. The stakeholder was asked to re-apply through FAA's certificate of waiver or authorization process. A day later, FAA officials reached out to the stakeholder and told it to not apply because the request would be rejected by one of the other FAA offices. According to this stakeholder, its large drone has been grounded for several months and it has yet to receive clear communication about how to proceed with the operational request. Another industry stakeholder said that when applying for a Part 107 waiver it was told by one FAA office that its waiver would be approved. A different FAA office later reached out to let it know its waiver would not be approved.

In addition, about half of the industry stakeholders (eight out of 15) said that in their view, because several FAA offices are involved in reviewing waiver and exemption requests, it takes a long time for FAA to reach a consensus among FAA offices and make a final decision on whether to approve or deny the application. One stakeholder stated that there is no singular authority over a single application that can make a final decision and that this creates challenges to working with FAA on operational requests. According to this stakeholder, this situation results in a "never-ending loop" of FAA staff giving feedback because each individual FAA office has its own timeline for reviewing requests.

FAA officials acknowledged that their operational request process is a complex process and not easy to follow. However, FAA officials said that they plan to take steps to improve documents and guidance that describe the operational request process. For example, FAA officials said that they developed a memorandum of agreement that describes FAA office roles and responsibilities for reviewing operational requests. FAA officials said that they plan to incorporate information from that memorandum of agreement in future guidance, which is planned to be published in August 2023. It will be important that FAA follow through on its planned actions to develop this guidance so as to provide external entities with clearer information about the agency's process for reviewing operational requests. Without a clear, documented process describing how FAA is completing its reviews of drone operation requests, FAA is limited in its ability to effectively communicate its process to applicants. This documentation can provide a means to communicate information as needed to external parties. Moreover, documenting FAA's process for conducting these reviews and communicating this information to applicants would help ensure that applicants better understand who is

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involved in these requests and what information applicants need to provide to various FAA offices.

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## FAA Does Not Have a Formal Lessons-Learned Process for Key Drone Integration Activities

FAA's lessons-learned process for its activities involving complex drone operations is informal and not documented. According to FAA documentation, one of FAA's goals is to use its pilot programs and its evaluation of waiver requests to identify lessons learned that can inform drone regulation development and help advance drone integration. Our prior work has shown that identifying lessons learned can help an agency ensure that beneficial information is factored into planning, work processes, and activities. We have previously identified six key practices that make up a formal lessons-learned process:

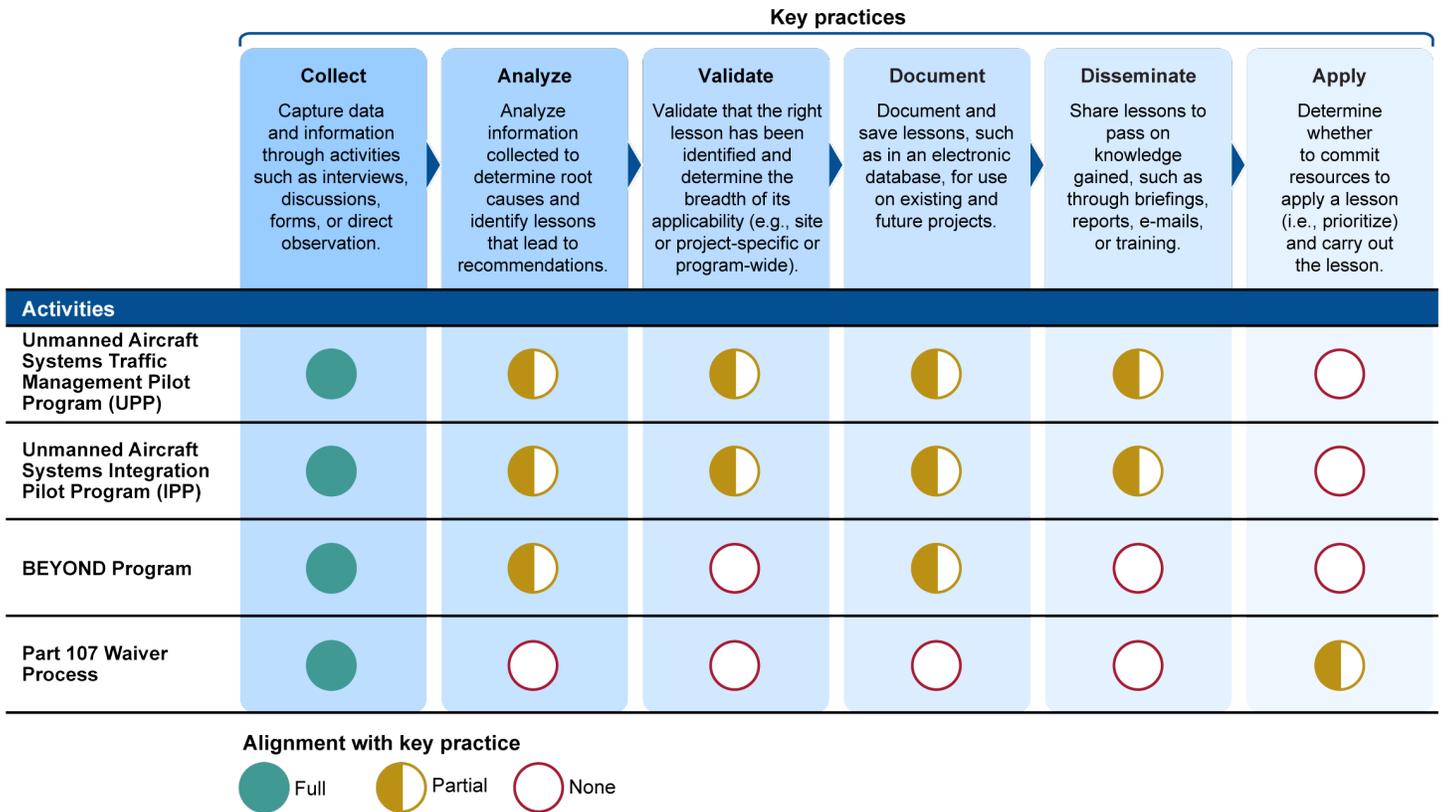
1. collecting data and information,
2. analyzing information to identify lessons learned,
3. validating lessons learned,
4. documenting lessons learned,
5. sharing lessons learned, and
6. applying lessons learned.<sup>48</sup>

We assessed FAA's use of the six key practices of a lessons-learned process in its three drone pilot program—UPP, IPP, and BEYOND—and in the Part 107 waiver process. Although FAA collects a substantial amount of information from these activities, we found that FAA's lessons-learned approach does not consistently align with key practices, and prevents the agency from fully leveraging this information to support integrating drones into the NAS.

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<sup>48</sup>See [GAO-12-901](#).

**Figure 3. Alignment of Federal Aviation Administration’s (FAA) Selected Drone Integration Activities with Lessons-Learned Key Practices**



Source: Analysis of prior GAO reports and the Center for Army Lessons Learned report, *Establishing a Lessons Learned Program: Observations, Insights, and Lessons*. | GAO-23-105189

### Collect

FAA’s collection of data and information from the integration activities we reviewed fully aligns with this key practice. For example, for both the UPP and IPP programs, FAA collected operational data from demonstrations completed during the programs in order to measure progress toward achieving program goals. FAA also collects a substantial amount of information and data as a result of its application requirements for Part 107 waiver requests. In particular, applicants are required to submit a concept of operations. This document includes a detailed description of the proposed drone operation, operational procedures, location, limitations, hazards, risks, and risk mitigations, and a separate operational-hazard and risk analysis.

In addition, participants in the pilot programs we reviewed have identified their own lessons learned from completed operations and shared them with FAA. Participants in the BEYOND program have shared lessons learned with FAA regarding a number of topics, such as operations over people, detect-and-avoid technologies, and package delivery. Similarly, according to FAA, program participants identified lessons learned regarding message security and flight “deconfliction,” for instance.<sup>49</sup>

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## Analyze

FAA’s approach to analyzing information and data it collects from the three pilot programs partially aligns with this key practice, but its approach for the Part 107 waiver process does not align. For example, FAA has conducted some analysis of the flight, aircraft, safety, and maintenance data that BEYOND participants have shared with the agency to assess and monitor progress toward meeting program goals. In addition, FAA officials told us they conduct some analysis of the data they collect through the Part 107 waiver process. For instance, they evaluate the number of days that FAA is spending reviewing Part 107 applications; total number of applications that have been reviewed, approved, and denied; and the complexity disposition of the waivers that have been reviewed (i.e., how many are highly complex, moderately complex, or routine). While these analyses help FAA monitor and describe the efforts undertaken as part of the pilot programs and the Part 107 waiver process, they do not produce the information FAA needs in order to further enable complex drone operations in the NAS.

According to our prior work, agencies should conduct root cause analysis to identify lessons that lead to recommendations.<sup>50</sup> We found that FAA has not analyzed the information it collects to determine root causes and derive lessons from these selected activities that lead to recommendations. Instead of conducting formal analysis to identify lessons learned, FAA uses other approaches for the selected activities. First, as mentioned above, FAA collects participant-identified lessons learned for its pilot programs. While this approach may yield some useful information, the lessons are site-specific, and therefore, do not result in program-wide lessons learned which only FAA is positioned to identify.

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<sup>49</sup>‘Message security’ refers to the protection of data exchanges between actors in the UTM ecosystem, a concept FAA calls a “critical enabler” of UTM. “Deconfliction” refers to the cooperative separation of multiple drones from each other in the airspace.

<sup>50</sup>[GAO-12-901](#).

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Further, as we discuss in the next section, FAA did not conduct additional analysis to validate these participant-identified lessons.

Second, for the Part 107 waiver process, FAA analyzes data to assess how efficiently it evaluates waiver requests. However, FAA officials stated that they do not have a formal process to analyze data and information collected from Part 107 applications for the purpose of identifying lessons learned. FAA's lack of formal analysis of these data may be due in part to limitations of the Part 107 database system. For example, when we requested that FAA provide us with data describing individual waiver applications, officials told us this would be very challenging and require a significant amount of coding. In addition, FAA's database lacks a field that would help officials easily identify more complex operations in order to facilitate a lessons-learned analysis.<sup>51</sup> Analyzing the data and information from these waivers, in particular, would help FAA to identify lessons officials have learned regarding approaches to safety risk mitigation for higher-risk operations.

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## Validate

While FAA's approach to validating lessons learned identified from the UPP and IPP programs partially aligns with this leading practice, its approach for validating lessons learned from the BEYOND program and the Part 107 waiver process does not. FAA officials told us that they validated lessons learned from the UPP program by sharing the lessons with members of UTM engineering teams who discussed and analyzed the lessons. Similarly, FAA officials said a variety of FAA program staff and management assessed the IPP lessons learned before these lessons were included in the program's final report. However, FAA has not been able to provide us with documentation describing in more detail the agency's process for validating the lessons learned from the UPP and IPP programs. As a result, we were unable to determine the extent to which FAA's efforts aligned with this leading practice. In addition, FAA

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<sup>51</sup>Specifically, FAA officials said that the Part 107 database system does not have a field that would allow FAA to identify Part 107 requests that have undergone a safety risk management (SRM) assessment. Operations that have undergone an SRM assessment generally include operations that are more complex and include new hazards that could cause or contribute to an aircraft accident. FAA officials told us that although the "Notes" field in the database indicates whether an SRM assessment should be conducted, that field is not searchable.

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has not taken steps to validate lessons learned from the BEYOND program or the Part 107 waiver process.

According to our prior work, validating lessons learned consists of (1) confirming that the identified lessons are accurate and (2) determining the breadth of their applicability to other contexts (e.g., other projects, operations, etc.). Without confirming the accuracy and applicability of lessons learned from FAA's integration activities—particularly those lessons identified by organizations outside of FAA—the agency cannot be certain it is identifying lessons that could advance its drone integration efforts. Unless FAA develops a formal process for validating lessons learned from complex drone operations, its efforts to validate these lessons will continue to be incomplete and inconsistent. As a result, FAA may not be able to apply the lessons learned to effectively and efficiently further its drone integration efforts.

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## Document

FAA's approach to documenting lessons learned for the three pilot programs partially aligns with this leading practice, but FAA's approach to documenting lessons learned for the Part 107 waiver process does not align. Specifically, FAA officials told us they documented the lessons learned from the UPP and IPP programs in the programs' final reports. However, we found in our review of these final reports that the lessons learned were not easily discernible. Specifically, there were no headings or other labels to show where the lessons themselves were summarized in the text. Moreover, officials told us they do not separately record lessons learned from their review of Part 107 waiver applications. FAA officials acknowledged that they could better track and document lessons learned and that they are taking steps to do so for the BEYOND program.<sup>52</sup> FAA's efforts to begin documenting lessons learned identified by BEYOND program participants serves as a useful first step. In addition, it will also be critical that FAA document program-wide lessons learned from its drone integration activities.

According to our prior work, agencies should document lessons learned in an electronic format, such as in a database, that enables those who would benefit from the lessons to easily locate and retrieve them. When

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<sup>52</sup>Specifically, officials stated they were in the early stages of building a tracking mechanism for lessons learned, challenges, and other issues that BEYOND program participants identify.

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lessons are not consistently documented in a shared format such as a database or spreadsheet, there is an increased risk that the organization will not retain the lesson. Accordingly, agencies may then be more likely to repeat prior mistakes, and stakeholders will not be able to benefit from the knowledge the agency has gained through its activities.

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## Disseminate

FAA's approach to sharing lessons learned from UPP and IPP partially aligned with this key practice, while its approach for BEYOND and the Part 107 waiver process did not align. First, according to FAA officials, FAA disseminated lessons learned from UPP and IPP by posting information—including the IPP final report—on the programs' websites. However, as previously noted, we found it difficult to locate the lessons learned in the IPP final report. In addition, while IPP concluded in October of 2020, FAA did not publish the final report until December of 2021, more than a year later. Moreover, nearly half (seven of 15) of the industry stakeholders we spoke to stated that FAA was not transparent about the data and information it collected from IPP and BEYOND and how it was being used.<sup>53</sup>

Second, FAA officials stated that they share lessons learned from their review of Part 107 waiver applications with the public by posting guidance for applicants on the agency's website. However, while this guidance may have been informed by lessons learned, posting the guidance does not effectively disseminate the lessons themselves. Further, though officials told us they also shared lessons learned from waiver application reviews with officials drafting drone regulations, they were unable to provide documentation demonstrating this communication.

Our prior work suggests that agencies share their lessons learned with those who could benefit from the knowledge the agency has gained. Agencies can use a variety of mechanisms to communicate lessons, such as briefings, reports, or training sessions. Without taking steps to effectively share its lessons learned from complex drone operations, FAA cannot ensure that the broader drone stakeholder community benefits from the agency's experience with higher-risk drone operations not allowed under current regulations.

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<sup>53</sup>Similarly, in our report on drone test sites we discussed FAA's lack of transparency regarding how it might use the data it collected from test sites. See [GAO-20-97](#).

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## Apply

FAA's approach to applying lessons learned from the three drone pilot programs in our review does not align with this key practice, though the agency's approach for the Part 107 waiver process does partially align. First, FAA was not able to share examples to demonstrate how lessons learned from activities completed as part of UPP, IPP or BEYOND have been applied to the development of drone regulations already completed. Notably, in the Beyond Visual Line-of-Sight Aviation Rulemaking Committee's final report, the committee stated that the IPP final report was not made available to the committee, and that consequently the committee could not take IPP lessons learned into consideration.<sup>54</sup> Therefore, not only has FAA not identified program-wide lessons learned, but the committee also was limited in its ability to draw on the experience of IPP when developing recommendations to FAA for a beyond visual line-of-sight rule.

Second, FAA officials stated that lessons learned from their reviews of Part 107 waiver information are generally incorporated into FAA's rulemaking efforts, and they provided documentation stating this had occurred for one rulemaking. Specifically, FAA officials said that they developed the final Operations of Small UAS Over People rule based on the lessons learned from previously approved Part 107 waiver applications.<sup>55</sup> However, the officials were unable to provide documentation that specified which lessons rulemaking staff applied, and how they applied them.

In prior work, we have stated that agencies should (1) determine whether to prioritize resources for applying a lesson learned and (2) if deemed necessary, apply the lesson. These actions constitute the final step in the lesson-learned process. Without considering whether to prioritize and apply the lessons FAA learns from its experience with complex drone operations, FAA cannot fully leverage the valuable knowledge it has acquired through its drone integration activities, and its lessons-learned process will be incomplete.

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<sup>54</sup>FAA officials told us the IPP final report review process was lengthy because it required involvement from stakeholders outside of FAA.

<sup>55</sup>See Operation of Small Unmanned Aircraft Systems Over People, 86 Fed. Reg. 4314 (Jan. 15, 2021).

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## FAA Is Working to Address Ongoing Technology, Community, and Workforce-Planning Challenges

FAA faces some long-standing challenges to integrating drones into the NAS, specifically related to technology, community concerns, and workforce-planning issues. FAA is taking some actions in each of these areas. However, some of these challenges will require actions by industry and other external stakeholders, in coordination with FAA, to fully address.

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## Technology

### Challenges

Three key technologies are critical to enabling complex drone operations: detect and avoid (DAA) technology, command and control (C2) systems, and a UTM system. Officials from FAA, DOD and some industry stakeholders and BEYOND lead participants we interviewed said addressing the challenges associated with these technologies will be critical to advance drone integration.

- **Detect and Avoid (DAA) technology.** Drone pilots are required by regulation and by statute to yield the right-of-way to other aircraft to prevent mid-air collisions.<sup>56</sup> For some drone operations, DAA technology may be needed to allow drones to safely maintain vertical and horizontal separation distances from other aircraft, avoid collisions with other aircraft, and avoid ground obstacles such as poles, power lines, trees, and mountains. According to FAA, DAA technology is an essential component of drones' operating beyond visual line-of-sight without visual observers.

FAA officials told us that developing a beyond visual line-of-sight rule will not be feasible without industry first developing a DAA standard. According to FAA, developing an industry standard for DAA technology will also provide FAA a basis for assessing and approving proposed detect and avoid options when applicants apply for approval of operational requests. FAA officials also stated that industry needs to mature these technologies and that the industry as a whole has not been able to develop detect and avoid technology that meet the size, weight, and power requirements for drones.<sup>57</sup> Some industry stakeholders and BEYOND lead participants stated that the lack of

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<sup>56</sup>14 C.F.R. § 91.111 requires all pilots to avoid operating aircraft so close to another aircraft as to create a collision hazard. 14 C.F.R. § 107.37 requires pilots of drones to yield the right of way to all aircraft. 49 U.S.C. § 44809 requires pilots of recreational drones to give way to crewed aircraft and avoid interfering with crewed aircraft.

<sup>57</sup>According to FAA, one of the most significant challenges to developing a DAA system is that the system needs to be small enough (in size, weight, and power) to be carried on a small drone. The system also has to be able to operate effectively at the low altitude environment utilized by most drones which can contain trees, buildings, and other infrastructure that create erroneous reports, block the "vision" of the sensor, or cause traffic to be lost in the background noise.

agreed-upon industry standards for DAA technologies is a challenge to drone integration.

- **Command and Control (C2) systems.** C2 systems provide drones with the capability to be operated beyond the visual line-of-sight of a pilot. These systems use radio-frequency spectrum to establish a communication link between the drone and its control station.<sup>58</sup> The drone industry faces several challenges related to developing agreed-upon standards and requirements for C2 systems. For example, the industry faces challenges in obtaining access to reliable and continuous spectrum. According to the beyond visual line-of-sight aviation rulemaking committee's final report, beyond visual-line-of-sight operations will require that spectrum bands with appropriate characteristics are sufficiently available to meet the needs of numerous users operating in a variety of operating environments. Determinations for which network approach (terrestrial, satellite-based, or airborne radios) should be used to sustain the drone C2 systems need to be made as well as the development of service rules for assigned spectrum to allow for manufacturers to develop and produce compliant C2 radios. Another challenge is developing C2 systems to be resilient to interference from other signals, link failures, or jamming attacks (illicit actions to inhibit communication), which could cause potentially dangerous situations, such as mid-air and ground collisions.
- **Developing a resilient UTM system.** As we have previously reported, developing and deploying a UTM ecosystem is a complex undertaking primarily because UTM requires establishing regulatory frameworks and developing operating rules and performance requirements.<sup>59</sup> Further contributing to the complexity, the roles, responsibilities, and activities that will collectively make up the UTM ecosystem are divided among various entities. For example, UTM is expected to be centered on the sharing of information among operators, and UAS service suppliers via an information exchange framework and airspace constraints set by the FAA. This approach will require coordination between FAA and various UAS industry stakeholders to develop operating rules and performance requirements for UTM operations. In addition, there are cybersecurity

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<sup>58</sup>In this report, spectrum refers to the radio-frequency spectrum. Spectrum is a scarce natural resource vital to many commercial and government activities. For example, the federal government uses spectrum for air traffic control, wildfire containment, weather observation, law enforcement, border security, national defense, and more.

<sup>59</sup>[GAO-21-165](#).

concerns with UTM, particularly concerns that potential cyberattacks could exploit design and implementation weaknesses in UTM software, hardware, or interfaces. FAA's concept involves the incremental development of a UTM ecosystem, primarily focused on developing low complexity operations and building in higher complexity operational concepts and requirements over time.

### FAA Actions

FAA has taken several actions to address DAA, C2, and UTM challenges, including undertaking research in these areas and coordinating with industry. For example,

- ASSURE, part of the FAA's Center of Excellence for UAS, conducts academic research critical to drone integration, and has identified DAA and C2 technologies among its research areas. As part of the ASSURE program, FAA is researching and testing voice and data communications to help establish C2 technical standards and regulations.
- Further, as noted earlier, FAA officials stated that as part of the type certification process, FAA is coordinating with industry applicants to define appropriate means of compliance for DAA system requirements that are dependent on the technologies' being proposed and the operational needs. FAA is also reviewing and providing feedback on each applicant's proposed collision avoidance strategies and documenting acceptable means of compliance utilizing the FAA issue paper process.<sup>60</sup>
- FAA officials told us that they are updating a UTM concept of operations and developing a UTM implementation plan. They said these plans are expected to be released by the end of 2022 and spring 2023 respectively. FAA officials said that they plan to incorporate performance goals and metrics for UTM implementation into a planned UAS implementation document, a recommendation we made in in 2021.<sup>61</sup>

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<sup>60</sup>The issue paper process is a formal communications vehicle for describing and tracking the resolution of significant technical, regulatory, and administrative issues that occur during a certification project. An issue paper may also be used to address novel or controversial technical issues.

<sup>61</sup>Specifically, we recommended that FAA develop performance goals and measures for its UTM implementation plan. [GAO-21-165](#).

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## Community Concerns

### Challenges

Communities have raised concerns related to drone integration—primarily about privacy, security, safety, and environmental issues related to drone operations. According to FAA officials, addressing these challenges will be critical to successfully integrating drone operations into the NAS.

- **Privacy.** Literature we reviewed cited several privacy concerns that communities have raised related to drone operations. These issues include concerns about government or non-governmental entities collecting personal data from approved drone surveillance (e.g., local police department conducting surveillance and collecting data). Similarly, most (seven out of nine) community representatives we spoke to stated that their communities most commonly raised privacy as a key concern, such as concerns about governmental or non-governmental entities using drones for surveillance purposes and infringing on individual privacy and civil rights. For example, one community representative stated that as drones become more reliant on sensors and cameras, people will have concerns about the types of data that are being collected, stored, and who can access that information. We have also previously reported that FAA officials state that they lack authority to regulate drone operations to address privacy concerns.<sup>62</sup> We further reported that uncertainty surrounding who has legal jurisdiction for various drone privacy issues presents challenges to integration of drones into the NAS. We reported that successful integration may involve balancing the social and economic benefits anticipated from drone operations with constitutionally protected privacy rights.
- **Safety.** Most (six out of nine) community representatives we spoke to said that safety of drone operations was also a key concern raised by community members. For example, three of these representatives stated that community members had raised concerns over the safety risks of drones for crewed aviation and also general fears about the potential risks of drones crashing to the ground. One representative noted that as drone package delivery becomes more common, community members will likely have more concerns or questions

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<sup>62</sup>GAO, *Unmanned Aircraft Systems: Current Jurisdictional, Property, and Privacy Legal Issues Regarding the Commercial and Recreational Use of Drones*, B-330570 (Washington D.C.: Sept. 16, 2020).

about those types of operations, and the extent to which those operations can be conducted safely beyond visual line-of-sight.

- **Security.** Some (three out of nine) community representatives we spoke to said that their communities also had security concerns related to drone operations. For example, one community representative stated that community members identified concerns that drones could be susceptible to cybersecurity attacks, as well as physical security risks related to the use of drones to damage critical infrastructure.
- **Environmental.** A few (two out of nine) community representatives we spoke to said that community members raised environmental concerns, including concerns about noise. One community representative stated that while there is optimism about drones potentially generating less pollution than conventional aviation or cars, there are concerns about other environmental impacts from drones, such as increased noise. In particular, this representative noted that drones generate a high-pitched sound which, although less noisy than conventional aircraft, could disrupt communities.

### FAA Actions

FAA has taken some actions to address community concerns related to drone integration. For example, FAA officials said that community engagement is a key component of the BEYOND program and that through that program, FAA is collecting information about community concerns. Specifically, BEYOND lead participants are required to develop formal community engagement plans describing their planned community engagement efforts. Participants are also required to identify and collect lessons learned about effective engagement approaches and share these lessons with FAA and other program participants. As previously discussed, FAA has not developed a formal process for identifying lessons learned from the BEYOND program.

Developing a formal lessons-learned process that could be applied to identifying lessons from ongoing community engagement activities could help FAA and BEYOND lead participants improve their efforts to address community concerns related to drone integration. FAA officials said that they are encouraging the participants in the BEYOND program to engage in community outreach in the local communities where their industry partners are operating, to better understand public perceptions of drone operations. More than half of the BEYOND lead participants we spoke to (seven out of eight) stated that they had conducted public education or

outreach efforts in their communities to obtain community views on drone operations. Four of the BEYOND lead participants we spoke to stated that these efforts helped alleviate concerns that communities may have had about privacy, security or other issues. The following are examples of such efforts by two of the BEYOND Lead participants:

- Virginia Tech Mid-Atlantic Aviation Partnership (VT-MAAP) officials said they conducted community sentiment surveys with industry partner Wing in the town of Christiansburg, Virginia, to better understand the views of community residents about drone operations in their community. According to VT-MAAP officials, the results of the survey were more positive compared to other community surveys on drone operations. VT-MAAP officials and representatives from the town of Christiansburg, Virginia, attributed this positive response to the education campaigns and outreach Wing conducted prior to the start of the delivery services. Specifically, representatives from the town of Christiansburg, Virginia, stated that VT-MAAP and Wing held many public meetings in which they displayed drone technology, and these meetings helped alleviate concerns that city residents had about security, noise, and safety.
- The Choctaw Nation of Oklahoma conducted various community outreach events with stakeholders, including conducting public safety and construction inspection flight demonstrations at their test site with their industry partner Skydio. According to officials from the Choctaw Nation of Oklahoma, community members in general have been enthusiastic about the program because given their rural location, drone delivery can help the community overcome significant infrastructure gaps. For example, drones can help circumvent narrow, winding roads to more easily deliver necessary medication or to collect information on a medical situation faster than an ambulance could reach the same location.

In addition, FAA officials stated that FAA has been developing noise certification requirements and procedures and collecting field measurement data to inform noise requirements and procedures. According to FAA, the agency is working to develop and implement a streamlined process for carrying out noise certification in the near term, while working to develop a generally applicable solution. In addition, FAA officials stated that they have also been working with industry and academia to develop noise reduction technologies, noise metrics, and low noise operational procedures, which would help address noise concerns that community members might have about drone operations. For example, according to FAA officials, FAA participates on several

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committees that are working to address noise certification issues, such as the NASA Urban Air Mobility Noise Working Group, SAE A-21 Technical Committee, and ICAO Committee on Aviation Environmental Protection, among others.<sup>63</sup>

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## FAA Workforce Challenges

Our prior work has highlighted challenges FAA faces with adapting its workforce to its increasing oversight activities, and ensuring that its workforce has the expertise and knowledge to oversee drone integration efforts. We have previously identified strategic human capital management as a high-risk area for federal agencies, and have reported that mission-critical skills gaps, both within federal agencies and across the federal workforce, impede the government's ability to effectively serve the public and achieve results.<sup>64</sup> We have made several recommendations to FAA in this area, which FAA has taken steps to implement:

- In 2019, we reported that FAA faced challenges in providing inspectors with sufficient drone-specific training and that FAA had not taken steps to formally assess whether inspectors' current drone training is sufficient.<sup>65</sup> We recommended that FAA identify drone-specific education and training needs for inspectors, and develop

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<sup>63</sup>The NASA Urban Air Mobility Noise Working Group includes noise experts from industry, universities, and government agencies working to identify, discuss, and address urban air mobility noise issues. The SAE A-21 Technical Committee develops recommended practices for aircraft noise measurement and guidance for modeling of both aircraft noise and aviation emissions to promote a unified technical approach to support the practical assessment of their impact. The Committee on Aviation Environmental Protection is a technical committee of the ICAO Council that assists the Council in formulating new policies and adopting new standards and recommended practices related to aircraft noise and emissions.

<sup>64</sup>GAO, *High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas*, [GAO-21-119SP](#) (Washington D.C.: March 2, 2021).

<sup>65</sup>GAO, *Unmanned Aircraft Systems: FAA's Compliance and Enforcement Approach for Drones Could Benefit from Improved Communication and Data*, [GAO-20-29](#) (Washington D.C.: Oct. 17, 2019).

appropriate training to address any needs identified.<sup>66</sup> In 2020, FAA implemented our recommendation by refining its training to help inspectors better perform key tasks and activities, and collecting data to target training to areas where inspectors demonstrate potential knowledge gaps.

- Additionally, in 2021, we reported that FAA’s workforce will need additional critical skills to support the increased use of drones.<sup>67</sup> We recommended that FAA ensure that planned skill gap assessments are based on quantitative information about gaps in all critical skills for employees across all mission-critical occupations. In April 2022, FAA officials stated they are working on a plan to quantitatively assess skill gaps for all of FAA’s Mission Critical Occupations and develop remediation actions to address skill gaps. FAA officials said that they plan to conduct competency gap assessments for these occupations in fiscal years 2023 and 2024.

FAA officials also stated that the agency’s budget submissions have included requests to increase plans to increase its drone workforce. In its fiscal year 2023 budget request, FAA requested \$4.9 million to hire more staff members—in the Office of Aviation Safety, Office of Policy, International Affairs, and Environment, Office of Integration and Engagement, and Office of the Chief Counsel—to support drone integration efforts, including reviews of Part 135 certification applications.<sup>68</sup> As previously discussed, identifying the resources the agency needs to achieve its integration goals is a key element of a comprehensive strategic plan. As FAA develops a drone integration

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<sup>66</sup>We also recommended that FAA develop an approach to more effectively communicate key information to local law enforcement agencies regarding their expected role with regard to small UAS safety oversight; and identify and obtain data needed to evaluate FAA’s small UAS compliance and enforcement activities. FAA subsequently implemented these recommendations. [GAO-20-29](#).

<sup>67</sup>See GAO, *FAA Workforce: Better Assessing Employees’ Skill Gaps Could Help FAA Prepare for Changes in Technology*, [GAO-21-310](#), (Washington D.C.: May 13, 2021).

<sup>68</sup>U.S. Department of Transportation, *Budget Estimates Fiscal Year 2023 Federal Aviation Administration*. The House Committee on Appropriations report accompanying the Transportation, Housing and Urban Development, and Related Agencies Appropriations Act, 2023 states that it “includes the request for additional staff and resources for [drone] integration, including supporting new rulemakings, managing international activities for emerging technologies with foreign civil aviation authorities, and greater coordination among the different offices in the FAA that are responsible for different aspects of certification.” H.R. Rep. No. 117-402, at 28 (2022) (incorporated by reference in the explanatory statement accompanying the Consolidated Appropriations Act, 2023, Pub. L. No. 117-328, 136 Stat. 4459 (2022)).

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strategy, it will be important that FAA accounts for the resources it will need to fully integrate drones into the NAS.

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## Conclusions

Over the last several years, FAA has taken steps to integrate routine and low-risk drone operations—within the line of sight of the operator—into the NAS. These actions have increased the number of commercial users and others who conduct drone operations for a wide range of uses. Although FAA has started developing a drone integration strategy to guide its efforts, the completion of the strategy has been delayed multiple times. As the drone industry continues to rapidly evolve, it is critical that FAA issue its drone integration strategy. Until FAA develops a strategy that incorporates all key elements of a comprehensive strategy, FAA risks not having the information it needs to effectively lead and manage its drone integration efforts, make well-informed decisions, and direct limited resources to specific purposes where they could be most beneficial.

In addition, FAA has not clearly communicated its requirements and process for reviewing operational requests for more advanced drone operations. Without effectively communicating how applicants can satisfy FAA's requirements, drone operators may be unable to provide FAA with the quality information it needs to assess their requests. In addition, without clearly communicating the process for reviewing operational requests, applicants do not have sufficient information to understand what entities are involved in these reviews and what information applicants will need to provide to various FAA offices. Communicating clearer information about FAA's requirements and process for reviewing operational requests could also help ensure that applicants are submitting more complete applications, submissions that in turn would help the agency more effectively manage current drone operations and assess various advanced, complex drone operations.

Finally, while FAA recognizes the importance of identifying and applying lessons learned from its UAS integration activities, it does not have a formal process for doing so. As drone operators continue to apply for approval of operational requests and as FAA undertakes additional pilot programs involving more complex operations, the agency will need to leverage the knowledge and experience it has gained from previously approved operations. Developing, documenting, and implementing a formal lessons-learned process for FAA's ongoing and future integration activities would enable FAA to more readily utilize valuable lessons to

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safely integrate increasing numbers of drones into the national airspace system.

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## Recommendations for Executive Action

We are making four recommendations to FAA:

- The Administrator of FAA should develop a drone integration strategy that includes all seven elements of a comprehensive strategy. (Recommendation 1)
- The Administrator of FAA should evaluate its current documentation to identify options to more clearly communicate how applicants can satisfy drone operational request requirements, and communicate FAA's internal process for reviewing and approving operational requests. (Recommendation 2)
- The Administrator of FAA should develop and document a formal lessons-learned process for its drone integration activities that includes all six key practices for a lessons-learned process. (Recommendation 3)
- The Administrator of FAA should implement the formal lessons-learned process it develops for its ongoing drone integration activities, including Part 107 waiver reviews and the BEYOND program. (Recommendation 4)

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## Agency Comments

We provided a copy of this product to the Department of Transportation (DOT), the Department of Defense (DOD) and the Choctaw Nation of Oklahoma for review and comment. DOT concurred with our recommendations and provided technical comments, which we incorporated, as appropriate. The Choctaw Nation of Oklahoma provided comments, which are reprinted in appendix III. DOD told us that they had no comments on the draft report.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretary of Transportation, the Chief of the Choctaw Nation of Oklahoma, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

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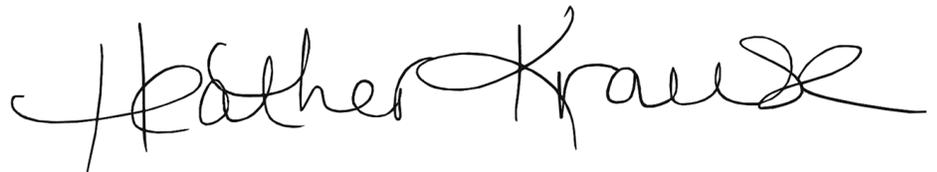
Letter

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If you or your staff have any questions about this report, please contact me at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink that reads "Heather Krause". The signature is written in a cursive, flowing style with a large initial 'H' and a decorative flourish at the end.

Heather Krause  
Director, Physical Infrastructure

# Appendix I: List of Entities GAO Interviewed

	Entity
Tribal Nation	Choctaw Nation of Oklahoma <sup>a</sup>
BEYOND Lead Participants	City of Reno (Nevada) <sup>b</sup> Kansas Department of Transportation Memphis-Shelby County Airport Authority (Tennessee) North Carolina Department of Transportation Northern Plains UAS Test Site <sup>c</sup> University of Alaska-Fairbanks Virginia Tech Mid-Atlantic Aviation Partnership <sup>d</sup>
Industry Stakeholders	ANRA Technologies BNSF Railway Commercial Drone Alliance Dominion Energy FedEx Flirtey Iris Automation Skydio Skyward (Verizon) Small UAV Coalition UPS Flight Forward Volansi Wing Xcel Energy Zipline
City and Community Representatives	City of Fort Collins, Colorado City of Hillsboro, North Dakota City of Los Angeles, California City of Ontario, California Detroit Region Aerotropolis Development Corporation Fairbanks North Star Borough, Alaska National League of Cities Town of Christiansburg, Virginia

Source: GAO. | GAO-23-105189

<sup>a</sup>The Choctaw Nation of Oklahoma is also a lead participant of FAA's BEYOND program. We interviewed tribal participants about their experiences with the BEYOND program and also about community views regarding drone integration efforts.

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**Appendix I: List of Entities GAO Interviewed**

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<sup>b</sup>We interviewed representatives from the City of Reno about their experiences with the BEYOND program and also about community views regarding drone integration efforts.

<sup>c</sup>The North Dakota Department of Transportation (NDDOT) is the official lead participant of the BEYOND program. NDDOT is working with the Northern Plains UAS Test Site on this program.

<sup>d</sup>The Center for Innovative Technology in Virginia is the official lead participant of the BEYOND program. The Center for Innovative is working with the Virginia Tech Mid-Atlantic Aviation Partnership on this program.

**Appendix II: Description of Drone Regulations  
in the United States, Canada, and the  
European Union**

# Appendix II: Description of Drone Regulations in the United States, Canada, and the European Union

Country or region	Drone regulations	Operations over people regulations	Remote identification (Remote ID) regulations	Beyond visual line-of-sight operations regulations
United States	In 2016, the Federal Aviation Administration (FAA) issued Part 107 regulations that allow routine operations of drones weighing less than 55 pounds so long as they meet certain restrictions. FAA may grant waivers to these restrictions on a case-by-case basis.	In 2021, FAA issued the final rule on drones operating over people and at night. The final rule allows routine operations over people and routine operations at night under certain circumstances. The rule eliminates the need for these routine operations to receive individual Part 107 certificate of waivers from the FAA.	In 2021, FAA issued a final Remote ID rule requiring drones operating in the NAS to have the capability to broadcast the aircraft's identification, location, and performance information. To meet the requirements of the Remote ID rule, drone operators can operate a drone with (1) standard Remote ID capability that broadcasts identification, performance, and location information; (2) a Remote ID broadcast module, which is a device that broadcasts identification, takeoff, and location information; or (3) without Remote ID equipment at an FAA recognized identification area.	In 2021, FAA initiated an aviation rulemaking committee to develop recommendations for a rule that would enable beyond visual line-of-sight operations.

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European Union**

Country or region	Drone regulations	Operations over people regulations	Remote identification (Remote ID) regulations	Beyond visual line-of-sight operations regulations
Canada	<p>In 2019, Canada issued regulations for Remotely Piloted Aircraft Systems (RPAS) that weigh from 0.55 to 55.1 pounds and that are operated within the drone pilot’s visual line of sight.</p> <p>According to Transport Canada documents, the regulations establish two main categories of drones operation:</p> <p>(1) Basic operations—requires five conditions, including flying in uncontrolled airspace, flying more than 30m (100ft) from bystanders, never flying over bystanders, flying more than three nautical miles from airports or military aerodromes, and flying more than one nautical mile from heliports; and</p> <p>(2) Advanced operations—includes operations in any of the following conditions: flying in controlled airspace, flying over bystanders, flying within 30 m (100 ft.) of bystanders, flying less than 3 nautical miles from airports or military aerodromes, and flying less than one nautical mile from a heliport.</p>	<p>According to Transport Canada documents, Canada’s RPAS regulation permits operations over people under the Advanced category. Operations over people are not allowed under the Basic category.</p>	<p>According to Transport Canada’s 2025 Drone Strategy, the agency has not issued a Remote ID rule for drones, but is exploring options. According to the strategy, Remote ID will serve as a foundational part of Canada’s drone traffic management system.</p>	<p>According to Transport Canada documents, Canada’s RPAS regulation permits operations beyond visual line-of-sight under low-risk conditions with the issuance of a Special Flight Operations Certificate (SFOC).</p> <p>According to Transport Canada documents, in 2020, Canada’s Transport Canada published proposed regulations to amend Canada’s existing drone regulations and permit beyond visual line-of-sight operations in lower risk environments, such as rural and remote areas.</p>

**Appendix II: Description of Drone Regulations  
in the United States, Canada, and the  
European Union**

<b>Country or region</b>	<b>Drone regulations</b>	<b>Operations over people regulations</b>	<b>Remote identification (Remote ID) regulations</b>	<b>Beyond visual line-of-sight operations regulations</b>
Europe	In December 2020, the European Union Aviation Safety Agency’s (EASA) drone regulations for hobbyist and commercial drone operations became effective. According to EASA documents, these regulations established requirements for three categories of drone operations: (1) Open (or “low-risk” operations) that do not require authorization but are subject to operational limitations; (2) Specific (or “medium-risk” operations) that require authorization from the national aviation authority on the basis of a risk assessment; and (3) Certified (or “high-risk” operations) that require certification and licensing.	According to EASA documents, operations over people are not allowed in the Open category unless the drone weighs less than 250g and meets other requirements. According to FAA, operations over people are not allowed in the Specific or Certified categories without a special authorization.	According to EASA documents, drones in certain classes are required to have a direct remote identification system that broadcasts specific data such as the drone’s unique serial number. The system must ensure, in real time during the whole duration of the flight, the direct periodic broadcast from the drone using an open and documented transmission protocol, in a way that it can be received directly by existing mobile devices within the broadcasting range. There is also an option for a network remote identification that shares the data in a way that it can be received through a network.	In April 2020, EASA issued a Notice of Proposed Amendment to clarify the conditions under which a beyond visual line-of-sight operation over a populated area or an assembly of people can be authorized in the specific category.

Source: GAO summary of FAA, Transport Canada, EASA and other documents. | GAO-23-105189

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## Appendix III: Comments from the Choctaw Nation of Oklahoma

**Appendix III: Comments from the Choctaw  
Nation of Oklahoma**



**Choctaw Nation of Oklahoma**

PO Box 1210 • Durant, OK 74702-1210 • Phone: 580.924.8280

Gary Batton  
Chief

Jack Austin, Jr.  
Assistant Chief

Submitted via:  
Maria Mercado / Senior Analyst, Physical Infrastructure  
Government Accountability Office / Los Angeles Field Office

January 4, 2023

Re: Choctaw Nation of Oklahoma Response and Comments for GAO Report GAO-23-105189

Halito (Hello), Ms. Mercado:

We have received and reviewed the draft report titled “*Drones: FAA Should Improve Its Approach to Integrating Drones into the National Airspace System*”, and we believe the report is accurate and provides a compelling set of actionable recommendations for the Federal Aviation Administration (FAA) to safely integrate drones into the national airspace system (NAS). We believe that our comments and input to the GAO study are accurately represented in the draft report. We have no suggested revisions or edits.

The Choctaw Nation of Oklahoma is a proud partner in promoting aviation safety and the safe and responsible adoption of emerging aviation technologies. The Choctaw Nation’s role in the UAS Integration Pilot Program (IPP) and the BEYOND Program represent important historic firsts for tribal governments and are a point of great pride for our tribal members. We are optimistic and excited about the future of these important collaborations and the potential for significant societal benefits for our tribal members and communities resulting from the adoption of emerging aviation technologies.

We appreciate the opportunity to provide feedback, and we look forward to future cooperation with the GAO.

Yakohe (Thank you),

A handwritten signature in blue ink that reads "Gary Batton".

Gary Batton, Chief  
Choctaw Nation of Oklahoma

# Accessible Text for Appendix III: Comments from the Choctaw Nation of Oklahoma

Submitted via: [MercadoM@gao.gov](mailto:MercadoM@gao.gov)

Maria Mercado / Senior Analyst, Physical Infrastructure  
Government Accountability Office / Los Angeles Field Office

January 4, 2023

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Yakoke (Thank you),

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**Accessible Text for Appendix III: Comments  
from the Choctaw Nation of Oklahoma**

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Gary Batton, Chief  
Choctaw Nation of Oklahoma

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## Appendix IV: GAO Contact and Staff Acknowledgments

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### GAO Contact

Heather Krause, (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov)

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### Staff Acknowledgments

In addition to the contact named above, Susan Zimmerman (Assistant Director); Maria Mercado (Analyst-in-Charge); Melissa Bodeau; Camilo Flores; Ned Malone; Jennifer Natoli; Josh Ormond; Kelly Rubin; Michael Soressi, Janet Temko-Blinder, and Ashni Verma made key contributions to this report.

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